Appendix D

Operational Characteristics of EIS Alternatives

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D. Operations

> Some tables in this appendix use the following numbers to identify the alternatives:
>
> - Alternative 1 (No Action Alternative)
> - Alternative 2 (Participants' Proposed Action)
> - Alternative 3 (Wetland Alternative)
> - Alternative 4 (Arkansas River Alternative)
> - Alternative 5 (Fountain Creek Alternative)
> - Alternative 6 (Downstream Intake Alternative)
> - Alternative 7 (Highway 115 Alternative)

D.1 Water Supplies

As discussed in Chapter 1 and Appendix A, the primary water supplies for the SDS Project would include water currently owned by the Participants in the Colorado Canal System (or other former agricultural systems) and reusable return flows, which result from existing transmountain water supplies.

Water rights owned in the Colorado Canal System would be delivered to either regulating storage, upper Arkansas River Basin storage or diversion facilities or to the untreated water intake by exchange. Depending on the alternative, reusable return flows would be delivered to either regulating storage, upper Arkansas River Basin storage or diversion facilities, or to the untreated water intake by exchange or direct diversion.

D.1.1 Surface Water Diversions

Water would be delivered to the untreated water intake from regulating storage in Pueblo Reservoir by direct release for the Participants' Proposed Action, Wetland, Arkansas River, and Downstream Intake alternatives, or water stored in Twin Lakes previously used to fill the Homestake pipeline would be released to the Arkansas River for diversion at the Highway 115 Intake and new exchanges would be made to an upgraded Ark-Otero Intake on the Arkansas River to fill the Homestake pipeline for the No Action and Highway 115 alternatives. In the Highway 115 Alternative, Fountain and Security would trade water and/or conveyance space in the SDS pipeline with Colorado Springs to account for deliveries to those entities from Colorado Springs' Twin Lakes account.

Mean annual SDS Project water supplies by water supply type are presented in Table D-1. For example, in the Participants' Proposed Action, 51,500 ac-ft per year of Colorado Springs' SDS Project water would come from regulating storage. Reusable return flows are exchanged from Fountain Creek, return flow storage or Colorado Canal into regulating storage prior to being diverted into the untreated water intake. Direct deliveries of

> **Hydrologic Modeling and Yield Analysis**
>
> The hydrologic analysis performed with using the SDS daily hydrologic model and summarized in this appendix is intended to quantify the hydrologic effects of proposed SDS Project operations in 2046. The Daily Model is a basin-wide operational model that approximates daily diversions and deliveries in 2046. It does not necessarily simulate a municipal or agricultural water user's full water supply collection, storage, and distribution system. Therefore, the model is not intended to and cannot be used to simulate SMAPD or Firm Yield for any water supply system. The values contained in this appendix should not be assumed to be reflective of SMAPD or Firm Yield for the Participants. SMAPD and Firm Yield are calculated by the Participants using separate procedures (Higgins 2005; MWH 2005; Black & Veatch 2004; Harding 2004).

Table D-1. Mean Annual SDS Project Arkansas River Diversion Sources.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Colorado Springs							
Reusable Return Flow Direct Diversion	0	0	0	0	0	52,400	0
Regulating Storage	0	51,500	56,300	55,500	52,200	4,300	0
Twin Lakes Tunnel	600	700	800	800	700	100	600
Twin Lakes Storage	50,900	6,100	1,300	1,200	4,600	900	56,200
Sub-Total†	51,500	58,300	58,400	57,500	57,500	57,700	56,800
Security							
Reusable Return Flow Direct Diversion	0	0	0	0	0	1,300	0
Regulating Storage	0	400	400	400	400	200	400
Sub-Total†	0	400	400	400	400	1,500	400
Fountain							
Reusable Return Flow Direct Diversion	0	0	0	0	0	1,000	0
Regulating Storage	0	1,100	1,200	1,200	1,100	900	1,100
Sub-Total†	0	1,100	1,200	1,200	1,100	1,900	1,100
Pueblo West							
Regulating Storage	0	2,800	2,800	0	2,800	0	0
Sub-Total	0	2,800	2,800	0	2,800	0	0
Total†	51,500	62,600	62,800	59,100	61,800	61,100	56,800

† Total supplies may not exactly equal total conveyed through SDS due to rounding.

Source: MWH 2008.

reusable return flows would occur only for those alternatives that have a point of diversion downstream of the reusable return flow accrual point (the Wetland, Arkansas River, and Downstream Intake alternatives). For the Wetland and Arkansas River alternatives, reusable return flows would be released from the return flow pipeline at Colorado 115 and would be stored in regulating storage before being introduced into the SDS intake; thus, the source of water for these alternatives is shown as regulating storage. For the remaining alternatives, reusable return flows would be delivered out of regulating storage. Pueblo West would not participate in SDS infrastructure if the Arkansas River, Downstream Intake, or Highway 115 alternative is selected; thus, no surface water diversions are shown for these alternatives. Pueblo West, however, would still store water in Pueblo Reservoir under these alternatives.

D.1.2 Exchanges

Exchanges are the primary means by which Colorado Springs, Fountain, and Security would maximize their use of reusable return flows in the No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives. Colorado Springs, Fountain, and Pueblo West have additional exchanges with the Colorado Canal System. Additional exchanges would be made by Colorado Springs from Pueblo Reservoir to Twin Lakes to supplement the transmountain water sources diverted through the Otero Pump Station (discussed below).

Mean annual simulated river exchanges into Pueblo Reservoir for the SDS Participants are presented in Table D-2. Mean annual exchanges into storage facilities or intake locations above Pueblo Reservoir are shown in Table D-3. Colorado Springs is the only Participant that would make exchanges to the upper Arkansas River Basin.

Mean annual contract exchanges for Colorado Springs and Fountain, the only Participants that would use contract exchanges, are presented in Table D-4. Contract exchanges also would be used to exchange water from restoration of yield (ROY) storage into Pueblo Reservoir. Colorado Springs' use of ROY storage and, consequently, ROY contract exchanges would vary among alternatives. No contract exchanges are shown for the No Action Alternative because there would be no excess capacity storage in Pueblo Reservoir under the No Action Alternative. No ROY contract exchanges are shown for Fountain because the SDS Project daily hydrologic

Table D-2. Mean Annual SDS Project River Exchange to Pueblo Reservoir.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Colorado Springs							
Fountain Creek	38,600	44,500	200	200	44,200	15,900	54,300
Return Flow Storage	7,900	16,900	0	0	17,000	300	9,200
Colorado Canal System	22,600	23,200	22,800	22,700	22,200	18,400	18,900
ROY Storage	1,000	200	0	0	100	0	100
Sub-Total	70,100	84,800	23,000	22,900	83,500	34,600	82,500
Security							
Fountain Creek	0	400	400	400	400	200	400
Sub-Total	0	400	400	400	400	200	400
Fountain							
Fountain Creek	0	200	300	400	200	100	300
Colorado Canal System	0	500	500	500	500	500	500
ROY Storage	0	100	100	100	100	0	100
Sub-Total	0	800	900	1,000	800	600	900
Pueblo West							
Wild Horse Creek	0	0	0	100	0	100	100
Colorado Canal System	300	300	300	300	300	300	300
Sub-Total	300	300	300	400	300	400	400
Total	70,400	86,300	24,600	24,700	85,000	35,800	84,200

Source: MWH 2008.

Table D-3. Mean Annual SDS Project River Exchange to Upper Arkansas River Basin.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Colorado Springs							
Turquoise Lake	7,000	5,500	4,100	4,100	4,900	4,200	5,100
Twin Lakes	17,900	18,800	16,400	16,600	16,300	16,100	17,600
Ark-Otero Intake	40,600	0	0	0	0	0	47,900
Total	65,500	24,300	20,500	20,700	21,200	20,300	70,600

Source: MWH 2008.

Table D-4. Mean Annual SDS Project Contract Exchanges.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Colorado Springs							
ROY Storage to Pueblo Reservoir	0	100	0	0	100	0	0
Pueblo Reservoir to Turquoise Lake	0	2,100	2,400	2,400	2,400	2,500	3,700
Pueblo Reservoir to Twin Lakes	0	2,900	3,200	3,100	3,100	2,500	3,600
Fountain							
ROY Storage to Pueblo Reservoir	0	300	300	300	300	200	300

Source: MWH 2008.

model is constructed to allow Fountain to make river exchanges first. Consequently, most water stored in ROY storage by Fountain would be moved to Pueblo Reservoir via river exchange rather than contract exchange.

D.1.3 Transmountain Imports

Simulated mean annual transmountain imports for each alternative are presented in Table D-5. Project Participants are direct beneficiaries of a portion of the Homestake Tunnel imports, Twin Lakes tunnel imports, and Boustead Tunnel imports. The Busk-Ivanhoe Tunnel imports benefit Aurora and the PBWW. All simulated transmountain imports are made under existing decreed water rights and associated limitations on the West Slope. Mean annual imports would be slightly greater (up to 4 percent) than for Existing Conditions for all alternatives but would not exceed the maximum allowable under existing decreed water rights and associated limitations on the West Slope.

D.2 Regulating Storage

Regulating storage would provide the Participants with the ability to store reusable return flows, changed consumptive use water,

Table D-5. Simulated Mean Annual Transmountain Imports to Upper Arkansas River Basin.

Entity	Existing Condition (ac-ft)	Maximum Allowable Imports (ac-ft)	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Homestake Tunnel	28,200	31,800	28,600	29,100	29,300	29,300	29,200	29,500	28,000
Twin Lakes Tunnel	37,700	42,200	41,700	39,200	38,600	38,800	39,500	38,700	41,300
Boustead Tunnel	65,800	65,800	65,800	65,800	65,800	65,800	65,800	65,800	65,800
Busk-Ivanhoe Tunnel	2,300	5,800	3,000	2,600	2,500	2,500	2,600	2,500	3,000
Total	134,000	145,600	139,100	136,700	136,200	136,400	137,100	136,500	138,100

†Simulated maximum allowable imports based on estimates by Grand River Consulting Corporation (MWH 2005).

Source: MWH 2008.

and other water that may be available for each Participant. Except for the No Action Alternative, regulating storage would occur as one or more long-term excess capacity storage contracts in Pueblo Reservoir, with Colorado Springs requesting 28,000 ac-ft, Fountain requesting 2,500 ac-ft, Security requesting 1,500 ac-ft, and Pueblo West requesting 10,000 ac-ft. The No Action Alternative would not include any new excess capacity storage in Pueblo Reservoir. Excess capacity contracts would allow the Participants to store non-Fry-Ark Project water in Fry-Ark storage space, provided there is space available after storing Fry-Ark Project water. Non Fry-Ark Project water and the Winter Water Storage Program water stored in excess capacity would be subject to spill in accordance with Article 13 of the SECWCD contract (Section 3.2.10).

Table D-6 presents a summary of mean storage contents and maximum storage contents for each alternative. The mean storage contents would typically be substantially less than the requested capacity for each entity because regulating storage typically would not serve as long-term carryover storage for the Participants. Rather, the storage would be used annually to store water during times of higher flow (when exchanges could be made) and release water to the SDS Project during times of lower flow.

Colorado Springs would be able to fill regulating storage to the maximum account capacity of 28,000 ac-ft during several years in the hydrologic modeling study period (1982 to 2004). With its existing water supplies, Security would be able to fill between 0 and 800 ac-ft of its 1,500-ac-ft regulating storage account capacity. Fountain would be able to fill between 300 and 1,000 ac-ft of its 2,500-ac-ft regulating storage account capacity using existing water supplies. Given its existing water supplies, Pueblo West would use between 4,000 and 6,100 ac-ft of its 10,000-ac-ft regulating storage account capacity. Maximum capacity for Security would be near 0 for several alternatives because typically, daily demand through SDS would be greater than daily supply available. When the Fry-Ark reusable return flows that constitute Security's supply were exchanged or delivered to the untreated water intake, they would be immediately diverted through the untreated water intake for delivery to the water treatment plant.

Table D-6. Mean and Maximum Storage Contents in SDS Project Excess Capacity Accounts.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Mean Storage							
Colorado Springs	0	4,700	7,800	8,300	5,300	8,000	10,000
Security	0	0	0	0	0	0	0
Fountain	0	100	100	100	100	100	200
Pueblo West	300	900	800	700	900	1,000	800
Total	300	5,700	8,700	9,100	6,300	9,100	11,000
Maximum Storage							
Colorado Springs	0	28,000	28,000	28,000	28,000	27,100	28,000
Security	0	0	0	0	0	0	800
Fountain	0	400	400	400	400	300	1,000
Pueblo West	1,000	6,100	4,600	4,000	6,000	6,100	6,000
Total	1,000	34,500	33,000	32,400	34,400	33,500	35,800

Source: MWH 2008.

D.3 Untreated Water Intake and Conveyance

Mean annual diversions for the SDS intakes from the Arkansas River are presented in Table D-7. These values represent physical diversions by the SDS untreated water intake. Mean annual diversions by Pueblo West would be the same among all alternatives for which it is a Participant in SDS infrastructure. Annual diversions for Colorado Springs, Security, and Fountain would vary slightly among Action Alternatives. Annual diversions for the No Action Alternative would be substantially lower then those for the Action Alternatives for Colorado Springs and would be absent for Security and Fountain.

Table D-7. Mean Annual SDS Project Diversions from the Arkansas River.

Location	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Colorado Springs	51,600	58,300	58,400	57,600	57,500	57,600	56,800
Security	0	400	400	400	400	1,500	400
Fountain	0	1,100	1,200	1,200	1,100	1,900	1,100
Pueblo West	0	2,800	2,800	0	2,800	0	0
Total	51,600	62,600	62,800	59,200	61,800	61,000	58,300

Source: MWH 2008.

Mean monthly diversions for Colorado Springs, Security, and Fountain are presented in Table D-8. Mean daily flows through the SDS untreated water intake and conveyance, excluding Pueblo West, would be fairly consistent among the Action Alternatives. In general, flow through the SDS Project under 2046 demands would be at the 78-mgd capacity when either the total demand at the water treatment plant equals or exceeds the SDS Project capacity or when terminal storage is less than reservoir capacity. Water treatment plant demands would typically exceed SDS Project delivery capacity from about late April through early-October. The SDS Project would be used to fill terminal storage in the fall, typically from early October through December. SDS Project flow would then match water treatment plant demands from January through late April.

D.4 Terminal Storage

Terminal storage would be used as a forebay reservoir for the proposed water treatment facility. The reservoir would provide temporary storage of water delivered from the Arkansas River before introduction into the water treatment plant. Storage would vary seasonally and daily as water demands are met. Typically, peak day demands during the summer are greater than the maximum capacity of the SDS untreated water conveyance pipeline. Water stored in terminal storage would be used to meet these peak demands. Drawdowns from terminal storage would be replenished by the untreated water conveyance pipeline during low demand portions of the year when demand at the water treatment plant is less than the maximum untreated water conveyance pipeline capacity. Mean monthly simulated terminal storage contents for each alternative are presented in Table D-9.

Table D-8. Mean Monthly SDS Flow through Untreated Water Intake to Colorado Springs, Security and Fountain.

Month	Alt 1 (mgd)	Alt 2 (mgd)	Alt 3 (mgd)	Alt 4 (mgd)	Alt 5 (mgd)	Alt 6 (mgd)	Alt 7 (mgd)
Oct	67	67	67	66	66	69	71
Nov	42	56	57	55	54	57	60
Dec	20	33	34	31	31	34	31
Jan	14	23	23	23	23	26	23
Feb	7	16	17	17	16	19	14
Mar	16	26	27	27	27	29	21
Apr	32	48	48	48	47	50	39
May	64	74	73	73	73	74	69
Jun	74	75	75	74	75	75	76
Jul	71	75	75	74	74	75	74
Aug	71	74	74	73	73	74	72
Sep	71	71	71	70	70	71	72
Mean	46	53	54	53	53	54	52

† Flows do not include Pueblo West.

Source: MWH 2008.

Table D-9. Mean Monthly SDS Terminal Storage Contents.

Month	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Oct	25,800	27,100	27,100	27,600	27,600	27,600	25,600
Nov	27,700	28,800	28,800	29,200	29,200	29,200	27,700
Dec	28,100	30,300	30,300	30,400	30,400	30,400	29,100
Jan	28,000	30,400	30,400	30,400	30,400	30,400	29,200
Feb	27,700	30,500	30,500	30,500	30,500	30,500	29,100
Mar	27,300	30,400	30,400	30,400	30,400	30,400	28,700
Apr	26,600	30,300	30,400	30,400	30,300	30,400	28,000
May	25,500	29,900	30,000	30,000	29,900	30,000	27,000
Jun	24,600	28,500	28,600	28,800	28,700	28,800	25,800
Jul	23,500	26,900	27,000	27,300	27,300	27,300	24,400
Aug	23,100	26,100	26,200	26,600	26,500	26,600	23,600
Sep	23,600	26,000	26,100	26,600	26,500	26,600	23,700
Mean	25,900	28,700	28,800	29,000	29,000	29,000	26,800

Source: MWH 2008.

D.5 Water Treatment Plant and Treated Water Conveyance

The monthly amount of water to be treated at the proposed SDS water treatment plant is projected in Colorado Springs' Operations and Yield Model (MWH 2005). It is converted into daily values and provided to the SDS Project daily hydrologic model as a time-series input that varies by month and year and specifies the daily demand at the proposed SDS water treatment plant for Colorado Springs. For Fountain and Security, because their daily demands consistently exceed their portion of SDS Project capacity and because they are not participating in terminal storage, the daily and annual demand at the water treatment plant is presented as their total SDS Project capacity.

The mean annual amount of water that would be delivered to the water treatment plant for the Project Participants is presented in Table D-10. Annual demands and deliveries to Colorado Springs for the Action Alternatives range from about 28,000 to 78,300 ac-ft, with an annual average of about 58,500 ac-ft. Simulated demands at the water treatment plant would be met for all alternatives during all years.

Annual treated water deliveries for Security under the Action Alternatives would vary from nearly 0 ac-ft in extremely dry years to slightly more than full allocation (1,500 ac-ft) of 1,700 ac-ft. Because the No Action Alternative for Security does not include water treatment at any SDS water treatment plant, no demands are shown for the No Action Alternative. Maximum deliveries are slightly greater than SMAPD and Firm Yields shown in Chapter 1 due to occasional availability of water supply and unused capacity in the untreated water conveyance system to meet demands.

Annual treated water deliveries for Fountain under the Action Alternatives would vary from about 600 ac-ft to slightly more than full allocation (2,500 ac-ft) of 2,600 ac-ft. Because the No Action Alternative for Fountain does not include water treatment at any SDS water treatment plant, no demands are shown for the No Action Alternative. Maximum deliveries are slightly greater than original SMAPD and Firm Yields shown in Chapter 1 due to occasional availability of water supply and unused capacity in the untreated water conveyance system to meet demands.

Median daily deliveries to the water treatment plant by calendar month for Colorado Springs, Fountain, and Security are presented in Table D-11. The proposed water treatment plant capacity is 109 mgd, while the maximum median daily delivery to the water treatment plant (i.e., the highest median delivery for 365 simulated days) would be between 100 and 101 mgd for all alternatives.

The average annual delivery to Fountain and Security through SDS is less than the SDS delivery capacity available to each entity (2,500 ac-ft for Fountain and 1,500 ac-ft for Security). This is because the SDS daily hydrologic model shows that inadequate supplies would be available to fully supply the requested capacity.

For Fountain, the SDS daily hydrologic model assumes that FVA return flows would be used

Table D-10. Annual SDS Water Treatment Plant Deliveries.

Location	Alt 1 (ac-ft)‡	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Mean Deliveries							
Colorado Springs§	58,400	58,500	58,500	58,500	58,500	58,500	58,500
Security	0	400	400	400	400	1,500	400
Fountain	0	1,100	1,200	1,200	1,100	1,900	1,100
Total†	58,400	60,000	60,100	60,200	60,000	61,900	60,100
Maximum Deliveries							
Colorado Springs§	74,900	78,300	78,300	78,300	78,300	78,300	78,300
Security	0	600	600	600	600	1,700	600
Fountain	0	1,700	1,700	1,700	1,700	2,600	1,900
Total*	74,900	79,500	79,500	79,600	79,500	80,700	79,800
Minimum Deliveries							
Colorado Springs§	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Security	0	0	100	0	0	1,100	0
Fountain	0	600	900	900	500	1,100	0
Total*	28,000	29,300	29,300	29,400	29,300	30,500	29,400

† Total deliveries may not exactly equal sum of individual Participant deliveries due to rounding.

‡ Simulated demand year is 2046 for all alternatives.

§ Includes water from FVA administrative swap with Fountain (Alts 2-6) and FVA connector pipeline (Alts 1 and 7).

* Total minimum and total maximum are summed from total daily deliveries and not from annual summaries for each Participant. Because annual minimums and maximums for each Participant do not necessarily fall in the same year, the total of daily values may not equal the sum of the Participants' minimum and maximum values.

Source: MWH 2008.

to meet well augmentation demands in the future, and would not be available for delivery to SDS. The available water supplies for Fountain are Colorado Canal water owned by Fountain and exchanged to Pueblo Reservoir, and reusable return flows that accrue to Fountain Creek from use of reusable waters that are in excess of augmentation requirements. It is possible that Fountain could choose to use FVA return flows to supplement its SDS supply, and develop other sources of water to replace the amount of augmentation currently supplied by FVA return flows. The FVA return flows could be exchanged to Pueblo Reservoir under existing exchange decrees. The amount of FVA water currently assumed to be used for well augmentation is approximately 1,300 ac-ft per year. Assuming that most of this amount could be exchanged given the availability of Colorado Canal and ROY storage to temporarily store return flows that cannot be immediately exchanged, and assuming successive use and reuse of this water, it is likely that Fountain could fully supply SDS when supplemented by FVA return flows. If a full SDS supply were assumed (an additional 1,300 to 1,400 ac-ft per year), effects on streamflow and reservoir contents would be slightly different than those shown for all Action Alternatives. Exchanges would result in increased average annual streamflow in lower Fountain Creek up to 2 cfs, decreased average annual streamflow in the Arkansas River between Pueblo Reservoir and Fountain Creek up to 2 cfs, and an increase in Pueblo Reservoir Storage up to 2,200 ac-ft per year.

For Security, the SDS daily hydrologic model assumes that FVA return flows would be used first to meet historical levels of well augmentation demands, with the remaining amount available for delivery to SDS. Security has no other existing water supplies available to supply SDS. Like Fountain, it is possible that Security could choose to use FVA return flows to supply SDS, and develop other sources of augmentation supplies to replace the FVA water. Sewered FVA return flows could be exchanged to Pueblo Reservoir under existing exchange decrees. However, the amount of FVA return flows assumed in the Daily Model to meet augmentation demands for Security is less than 200 ac-ft per year, which is not enough to fully supply the requested delivery capacity. If Security chose to use this water to meet SDS water supply requirements, assuming successive use and reuse of this water and that it could all be exchanged, average annual streamflow in lower Fountain Creek would increase by less than 1 cfs, streamflow in the Arkansas River between Pueblo Reservoir and Fountain Creek would decrease less than 1 cfs. Effects on Pueblo Reservoir storage would be negligible. Because Security does not have the ability to store return flows that cannot be immediately exchanged, Security is unable to take full delivery of FVA return flows when exchanges are required to deliver them to the SDS untreated water intake (all Action Alternatives except the Downstream Intake Alternative (Alternative 6)).

Table D-11. Median Monthly and Maximum SDS Water Treatment Plant Deliveries.

Month	Alt 1 (mgd)†	Alt 2 (mgd)	Alt 3 (mgd)	Alt 4 (mgd)	Alt 5 (mgd)	Alt 6 (mgd)	Alt 7 (mgd)
Oct	60	62	62	62	62	65	62
Nov	34	37	38	38	37	40	37
Dec	28	31	31	31	31	34	31
Jan	21	21	22	22	21	23	23
Feb	12	14	14	14	14	17	14
Mar	20	20	21	21	20	23	20
Apr	48	50	50	50	50	51	49
May	81	83	82	82	82	83	82
Jun	93	94	93	93	94	94	94
Jul	88	89	89	89	89	89	89
Aug	75	76	76	76	76	76	76
Sep	69	70	70	70	70	70	70
Maximum Median	100	100	100	100	100	101	100

† Simulated demand year is 2046 for all alternatives.
Source: MWH 2008.

D.6 Return Flow Storage

Return flow storage would be used to temporarily store Colorado Springs' reusable return flows that could not be immediately exchanged to Pueblo Reservoir or the upper Arkansas River Basin facilities. The reusable return flows stored in return flow storage would be released during higher flow times when adequate exchange potential exists in the Arkansas River Basin. Because return flow storage is only needed for those alternatives that require exchanges to deliver or store reusable return flows, return flow storage is not included for alternatives that do not require exchanges (the Wetland and Arkansas River alternatives). Return flow storage would not include any emergency storage because water stored in return flow storage would not be directly accessible by the water treatment plant (MWH 2005).

Mean monthly simulated reservoir contents in return flow storage (Williams Creek Reservoir) are presented in Table D-12. A time-series analysis (MWH 2008) indicates that reservoir contents for all alternatives would vary seasonally, with minimum contents typically occurring in summer and maximum contents typically occurring in late spring. In general, the reservoir would fill when there is more return flow than there is exchange potential and would empty when there is more exchange potential than there are return flows.

The No Action Alternative reservoir contents would remain high for all years in the study period because, without storage in Pueblo Reservoir, Williams Creek Reservoir would hold all the return flows that are not immediately exchanged to the upper Arkansas River Basin or passed downstream to Colorado Canal. Because an exchange from Fountain Creek to the upper Arkansas River Basin is more difficult than an exchange from Fountain Creek to Pueblo Reservoir, return flows would be held in Williams Creek for a longer period of time. Simulated reservoir contents in return flow storage would be intermediate for the two alternatives that rely on exchanges from Fountain Creek to Pueblo Reservoir and participate in the Pueblo Flow Management Program (the Participants' Proposed Action and Fountain Creek Alternative). This is because the SDS Project could not directly divert reusable return flows; therefore, if they could not be immediately exchanged due to lack of exchange potential or PFMP curtailments, they would be stored in return flow storage.

In the Highway 115 Alternative, which also relies on exchanges from Fountain Creek to Pueblo Reservoir, Colorado Springs would not participate in the Pueblo Flow Management Program because the untreated water intake would not come out of Pueblo Dam. Therefore, it would be easier for exchanges of reusable return flows to be made directly into Pueblo Reservoir, and the reusable return flows would not need to be stored in Williams Creek Reservoir as often as in the Participants' Proposed Action and Fountain Creek Alternative. In the Downstream Intake Alternative, reusable return flows would be delivered directly to the diversion location below the Fountain Creek confluence. However, reusable return flows would still require exchange into Pueblo Reservoir for regulating storage. Consequently, reusable return flows would be stored only in return flow storage if the reusable return flow was greater than either the SDS capacity or the

Table D-12. Mean Monthly Return Flow Storage.

Month	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Oct	22,100	6,000	0	0	6,200	1,500	4,100
Nov	23,500	6,200	0	0	6,500	1,500	4,300
Dec	26,100	8,300	0	0	8,400	1,500	4,800
Jan	27,400	10,600	0	0	10,700	1,600	5,800
Feb	27,900	12,600	0	0	12,800	1,700	7,000
Mar	28,000	14,900	0	0	15,100	2,000	8,600
Apr	27,500	14,500	0	0	15,100	1,900	6,100
May	25,400	10,900	0	0	12,100	1,900	5,600
Jun	22,100	5,800	0	0	7,200	1,800	4,300
Jul	20,600	4,500	0	0	4,900	1,700	3,800
Aug	19,900	4,500	0	0	4,800	1,600	3,800
Sep	20,300	4,900	0	0	5,300	1,500	4,000
Mean	24,200	8,600	0	0	9,100	1,700	5,200

Source: MWH 2008.

available storage space in terminal storage, and there was no potential in the Arkansas River to exchange water into Pueblo Reservoir. This would result in less storage in the return flow reservoir for the Downstream Intake Alternative than for other similar alternatives. Table D-13 summarizes the percentage of the return flow capacity that would be used on a daily basis under 1982 through 2004 hydrologic conditions. For the No Action Alternative, the reservoir would remain nearly full. About 57 to 59 percent of the time, the reservoir would be nearly empty under the Participants' Proposed Action and Fountain Creek Alternative; however, the full capacity would be used nearly 8 to 9 percent of the time. For the Downstream Intake Alternative, the reservoir would consistently be less than 25 percent full. Component sizing was not optimized separately for each alternative. Thus, the optimum size of this reservoir may be smaller from some alternatives. Some component optimization may occur during final design of the Preferred Alternative.

D.7 Return Flow Conveyance

The simulated mean annual conveyance of reusable return flows through the return flow conveyance pipelines is shown in Table D-14. The return flow conveyance systems would convey reusable return flows to Fountain Creek or the Arkansas River for exchange or direct diversion by SDS. The Williams Creek Return Flow Conveyance Pipeline would convey reusable return flows from return flow storage to Fountain Creek immediately below the Owen and Hall diversion. Only releases from return flow storage would be conveyed in this pipeline. The Highway 115 Return Flow Pipeline configuration would convey reusable return flows from the J.D. Phillips Water Reclamation Facility and LVSWWTF to the Arkansas River at Colorado 115 near Florence. The Eastern Return Flow Pipeline would convey reusable return flows from return flow storage to the confluence of Fountain Creek and the Arkansas River. In this configuration all reusable return flows being delivered to the Arkansas River (both return flow storage releases and reusable return flows that are immediately exchanged or delivered to other Arkansas River locations) are conveyed in the pipeline. The Wetland and Arkansas River alternatives include the Highway 115 Return Flow Pipeline configuration while the Fountain Creek Alternative includes the Eastern Return Flow Pipeline. All other alternatives include the Williams Creek Return Flow Conveyance Pipeline.

The Highway 115 Return Flow Pipeline would be sized so that most exchangeable reusable return flows could be delivered to the Arkansas

Table D-13. Daily Usage of Return Flow Reservoir Capacity.

Storage Content	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6†	Alt 7†
0%-25% Full	2%	59%	No Return Flow Reservoir		57%	100%	87%
26%-50% Full	2%	22%			23%	0%	7%
51%-75% Full	17%	10%			11%	0%	2%
76%-100% Full	79%	8%			9%	0%	4%

† Components were not optimized separately for each alternative and were therefore simulated at the same maximum size.

Source: MWH 2008.

Table D-14. Mean Annual SDS Conveyance through Return Flow Pipelines.

Conveyance to Fountain Creek/ Arkansas River	Alt 1 (ac-ft)	Alt 2 (ac-ft)	Alt 3 (ac-ft)	Alt 4 (ac-ft)	Alt 5 (ac-ft)	Alt 6 (ac-ft)	Alt 7 (ac-ft)
Williams Creek Return Flow Conveyance Pipeline	7,900	17,000	0	0	0	200	8,200
Highway 115 Return Flow Pipeline	0	0	69,100	69,100	0	0	0
Eastern Return Flow Pipeline	0	0	0	0	63,000	0	0

Source: MWH 2008.

River through the pipeline; thus, deliveries would be consistent for the Wetland and Arkansas River alternatives. The mean annual flows through the Eastern Return Flow Pipeline configuration in the Fountain Creek Alternative would be less than the mean annual flow through the Highway 115 Return Flow Pipeline. This would occur because of transit losses in Fountain Creek and evaporative losses of reusable return flows that are stored in return flow storage. Because the Williams Creek Return Flow Conveyance Pipeline conveys only return flow reservoir releases, mean annual flow would be substantially less than the other two configurations.

D.8 General Facilities Operation and Maintenance Procedures

D.8.1 Operations and Control

Under all alternatives, SDS project facilities would be monitored continuously from Colorado Springs Utilities' existing Control Center. A Supervisory Control and Data Acquisition (SCADA) system would control and monitor the SDS facilities. Information on facilities status would be transmitted through fiber optic lines and a redundant microwave communications system linked to computers at the Control Center. The system would be connected to instruments or sensors to monitor pressure, flow, valve position, and other parameters, and would facilitate remote control of critical facilities. The system also would have an alarm system capable of notifying key personnel when emergency situations occur and would store operational data for accounting purposes. Under the No Action Alternative, Fountain, Security, and Pueblo West would monitor and operate their facilities through their individual, existing control centers. Alternatives consisting of multiple reservoirs (the No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives) would require more complex control systems, real-time operational decisions, and labor.

All pump stations would be designed to automatically shut down on power failure. A backup power supply (e.g., propane) would provide power to the lighting, instrumentation, and communications networks during a power outage. The control system would ensure communications among the pump stations. During shut down of the untreated water pumping system, the control system will prevent excessive water levels at any pump station. Emergency control valves and surge control facilities would be included in the pump stations. Surge control facilities would stop pressure surges caused by sudden pump shut down. These control systems and facilities would prevent a power outage from allowing excessive pressures in the untreated water conveyance pipeline. Should releases from the pipeline be necessary, overflow facilities for the pump station storage tanks would be designed to convey excess flows to a natural watercourse capable of handling them in an emergency event.

D.8.2 Conveyance Systems Maintenance

Untreated, treated, and return flow conveyance systems would be maintained in a similar manner. Untreated water pipelines would require routine maintenance inspections. This would consist of driving the pipeline alignments semi-annually and visually evaluating site conditions. These inspections would detect evidence of unauthorized excavation activity on or near rights-of-way, erosion and washout areas, areas of sparse vegetation, damage to permanent erosion control devices, exposed pipe, and other potential problems that might affect the safety and operation of the pipeline. In addition, pipeline markers and signs would be inspected and maintained or replaced, as necessary. Repairs to the right-of-way could include regrading and reseeding with appropriate plant materials or installing other soil stabilization measures. Maintenance roads would not be built along the pipelines. However, a permanent access road would be constructed from Squirrel Creek Road south to the Williams Creek Pump Station along the untreated water pipeline route. If a pipeline segment could not be accessed from a main road, a 4-wheel drive vehicle would be used.

Other maintenance operations would include valve maintenance (both air/vacuum and in-line), pipeline cathodic protection testing, pipeline equipment replacement or repair, and pump stations monitoring and maintenance. The air/vacuum valve maintenance would be done annually and would include driving to each valve station, opening and entering the vault access, inspecting and lubricating valves, performing maintenance and replacing broken or failed components. Annual in-line valve maintenance would consist of exercising or turning in-line valves and lubricating components exposed inside valve vaults or manholes.

Pipeline cathodic protection testing would be done annually and consist of driving along the pipeline alignment, testing the system at test stations spaced at roughly 1,500-ft intervals, setting up temporary anodes and the connection to each test station to check continuity and pipe-to-soil potentials (voltages).

Detailed visual surveys would be done every 2 to 3 years, which would require walking the pipeline alignment. Pipeline equipment replacement or repair would be done as needed or once every 10 to 15 years. Maintenance would consist of servicing or replacing failed in-line valves, flow meters, blowoff valves or other major components that require pipe shutdown. This would include draining, refilling, testing, and returning the pipeline to operation. This also would include the discharge of water at adjacent blow-offs (discussed in Chapter 2), pipeline excavation, and backfill and surface restoration.

Daily or weekly maintenance activities would include driving to each pump station to inspect the facility, facility grounds, and equipment and to test the equipment. Pump station maintenance also would include lubricating mechanical equipment and pumps based on manufacturer instructions, checking valves, testing the lighting and controls standby generator, testing the standby overhead crane if furnished and testing alarms and SCADA equipment. Routine maintenance would be performed on a scheduled basis and major overhauls would be likely after 10 to 15 years for each pump and its generator.

Maintenance equipment would consist of combinations of pickup or flatbed trucks, mowers, mechanical blowers, boom-trucks, excavators, loaders, and compactors depending upon the needs of the maintenance activity.

D.8.2.2 Terminal and Return Flow Storage Maintenance

Routine maintenance of the terminal and return flow storage reservoirs would include inspection of all facilities, dam safety inspections, inlet trash rack cleaning, equipment operation, lubrication, and replacement. Spillway repairs, erosion protection repairs downstream of discharge point, instrumentation inspection, calibration, and replacement would be performed as needed. General maintenance activities also would include litter removal, culvert cleaning, and mowing of selected areas if required for dam safety.

Maintenance equipment would consist of combinations of pickup or flatbed trucks, mowers, mechanical blowers, boom-trucks, excavators, loaders, and compactors depending upon the needs of the maintenance activity.

D.8.2.3 Water Treatment Plant Maintenance

Maintenance of the water treatment plant would include routine visual inspections, monitoring, equipment replacement, or repair and specialty maintenance. Routine maintenance would consist of observing, monitoring, and inspecting the plant daily. Maintenance activities would include lubricating mechanical equipment, monitoring and testing the alarms on standby equipment.

Equipment replacement or repair would be performed on a scheduled basis and would consist of checking valves and other major components. This activity would include closing valves and isolating the component requiring service, disconnecting header piping, draining the isolated line, and removing the valve or object needing repair or replacement. Specialty maintenance would be necessary for pump impeller, stator, or diaphragm replacement, equipment drive rebuilding and eventual replacement, ozone generation and destruct equipment repairs and replacement and filter media replacement.

Maintenance equipment would consist of combinations of pickup or flatbed trucks, mowers, mechanical blowers, boom-trucks, excavators, loaders, and compactors depending upon the needs of the maintenance activity.

D.9 References

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